Key Technologies for UAV Interoperability

41st Annual NDIA Symposium

Presented by: Dave Buis
The Boeing Company

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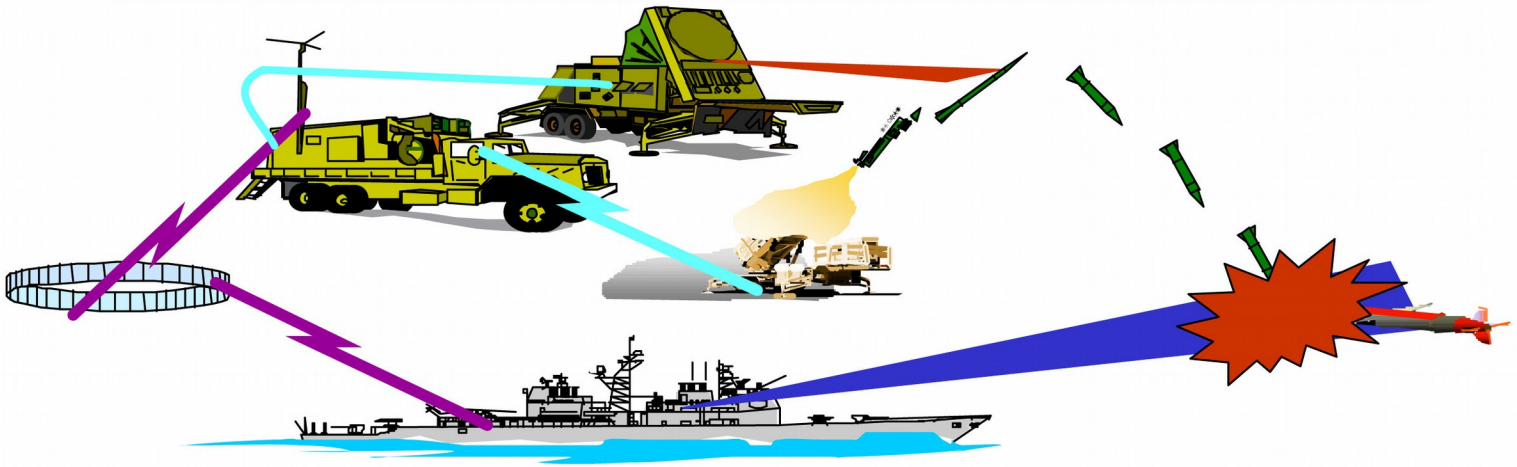
Agenda

- What is Interoperability
- UAV Roles and Missions
- UAV Interoperability in a System of Systems
- Interoperability Technologies
  - Mission Management
  - Communications
  - Processing Architecture / Infrastructure
  - Human Systems Interface
  - Cooperative Adaptive Autonomy
- Civil and Commercial Operations in the NAS
- Summary

What is Interoperability?

"We will connect Information systems and weapons in new ways"
President George Bush
New York Times, 25 March 2001



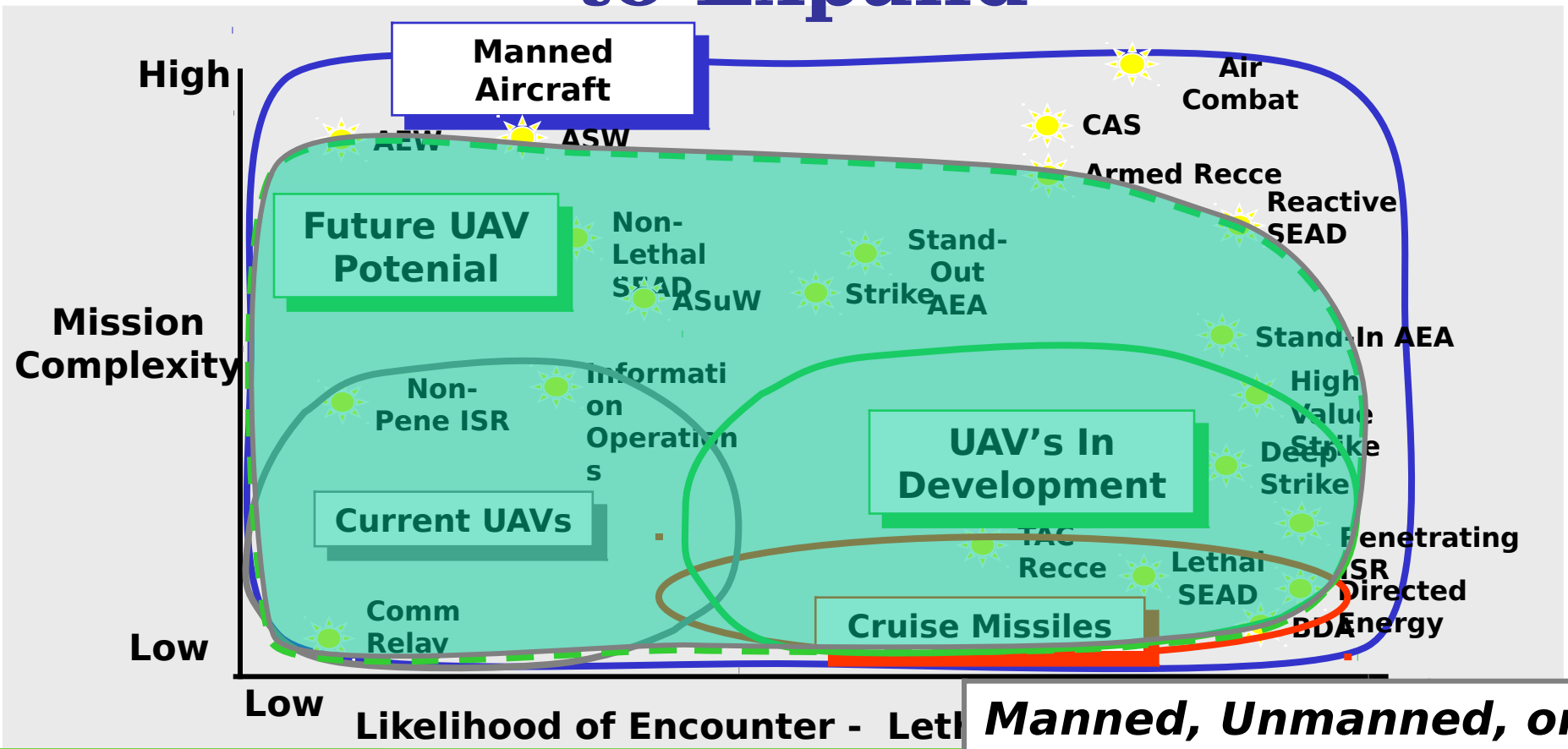
"The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together."

(JCS Pub 1)

Focus is on Effective Joint and Combined Operations

Vitale Garber, Interoperability OSD, NDIA, Systems Engineering Conference, October, 2002

Military Roles & Missions for Unmanned Systems Will Continue to Expand



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edium: Frequent near-real time decisions, compatible with machine de

gh: Numerous complex, real-time decisions / reactions by operator. Highly situation dependent

Manned, Unmanned, or Combined Options Available to Field Commanders

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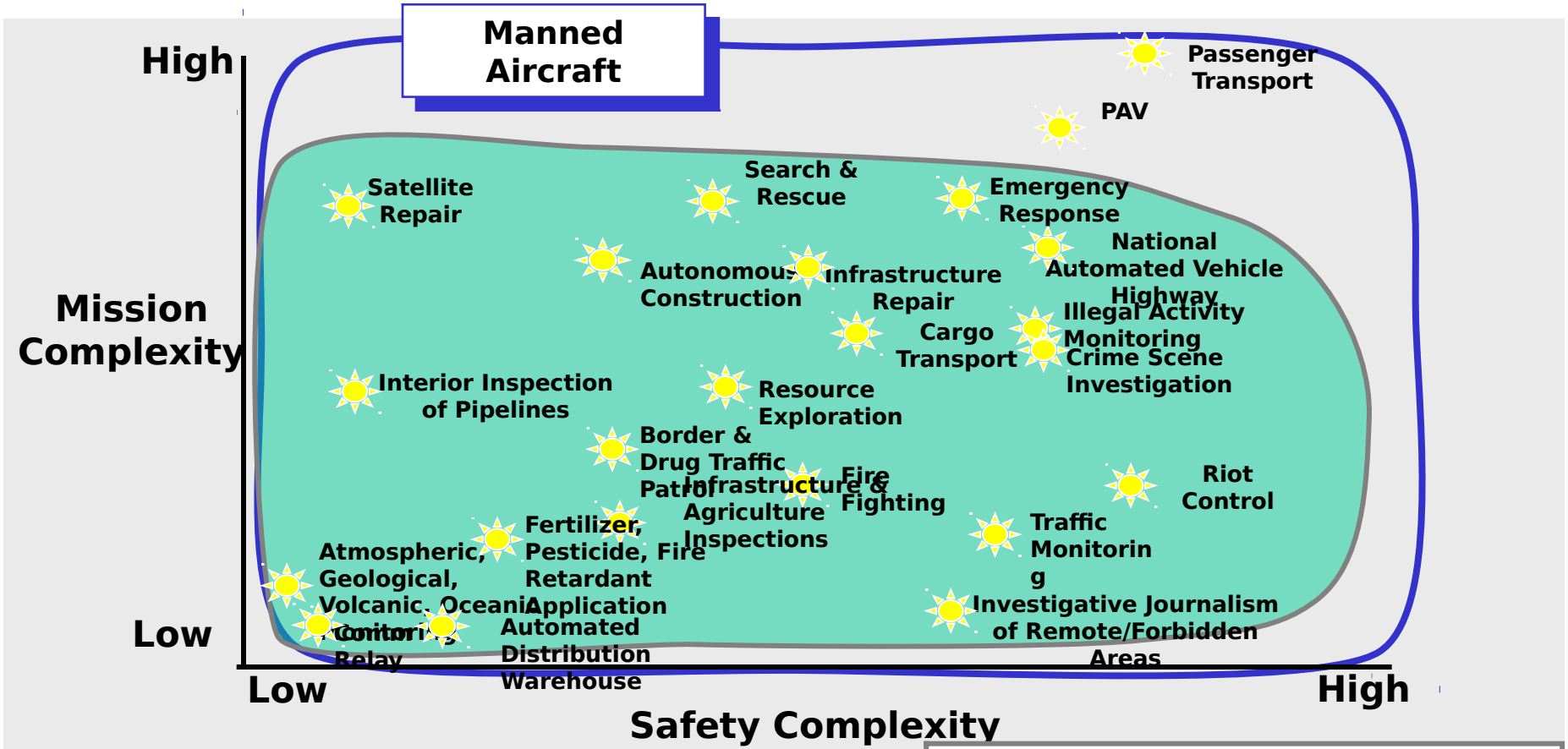
Roles and Missions for Unmanned Systems will Expand into Civil and Commercial Applications



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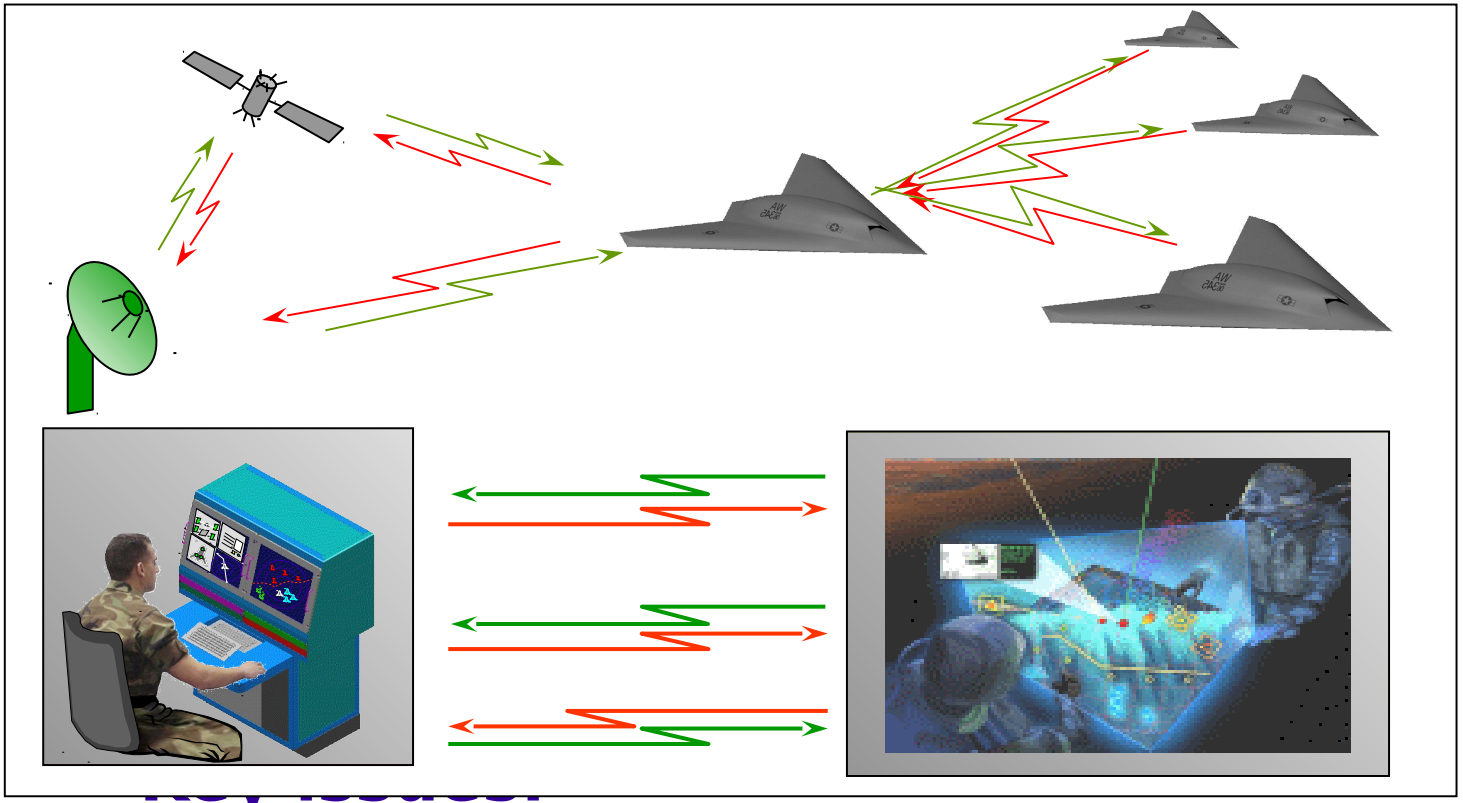
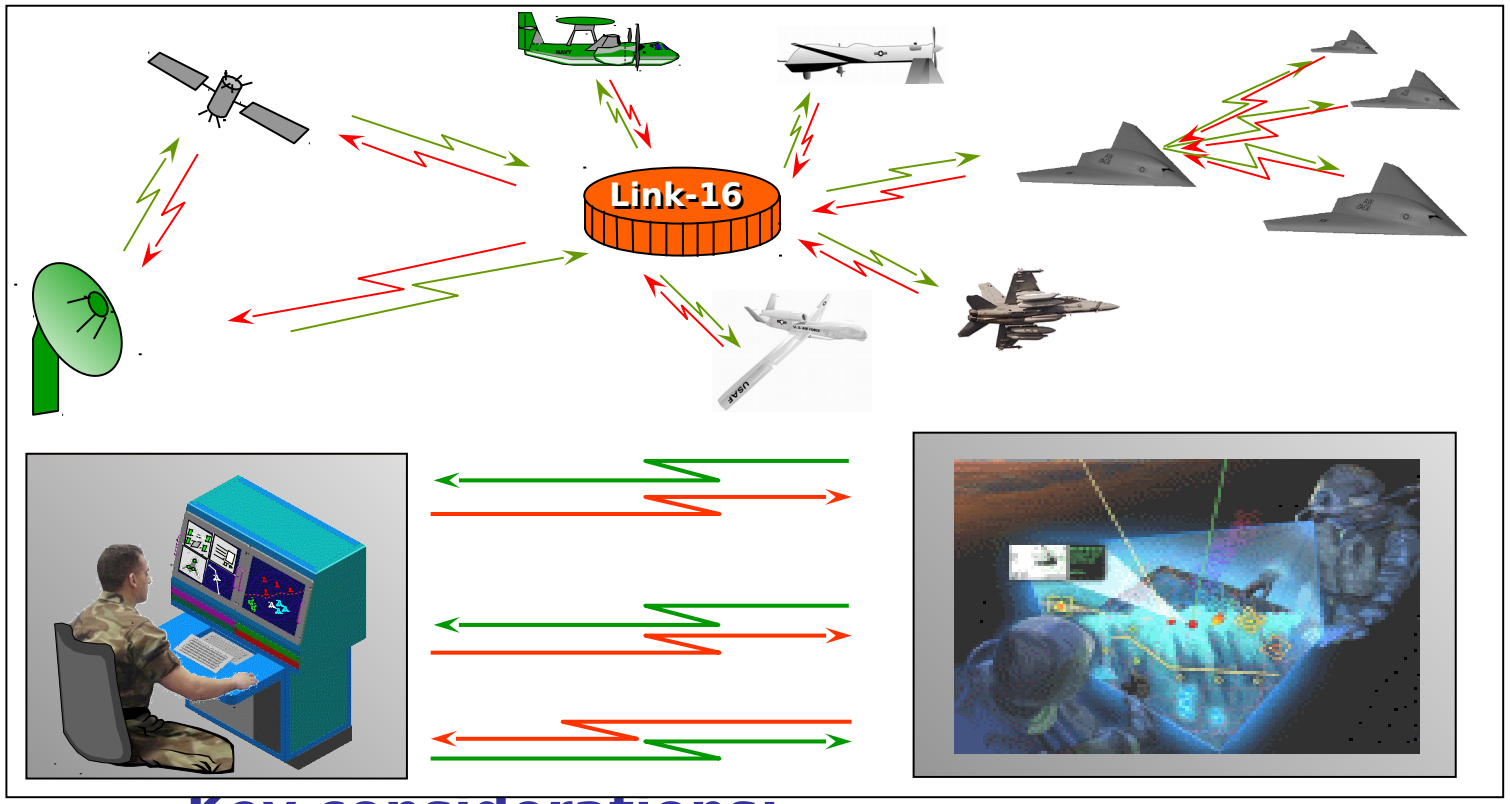
Manned, Unmanned, or Combined Options Available to Customers

An Unmanned System is a Network-Enabled System



- **Mission management architecture with cooperative, adaptive, autonomy**
- **Communications (connectivity, bandwidth)**

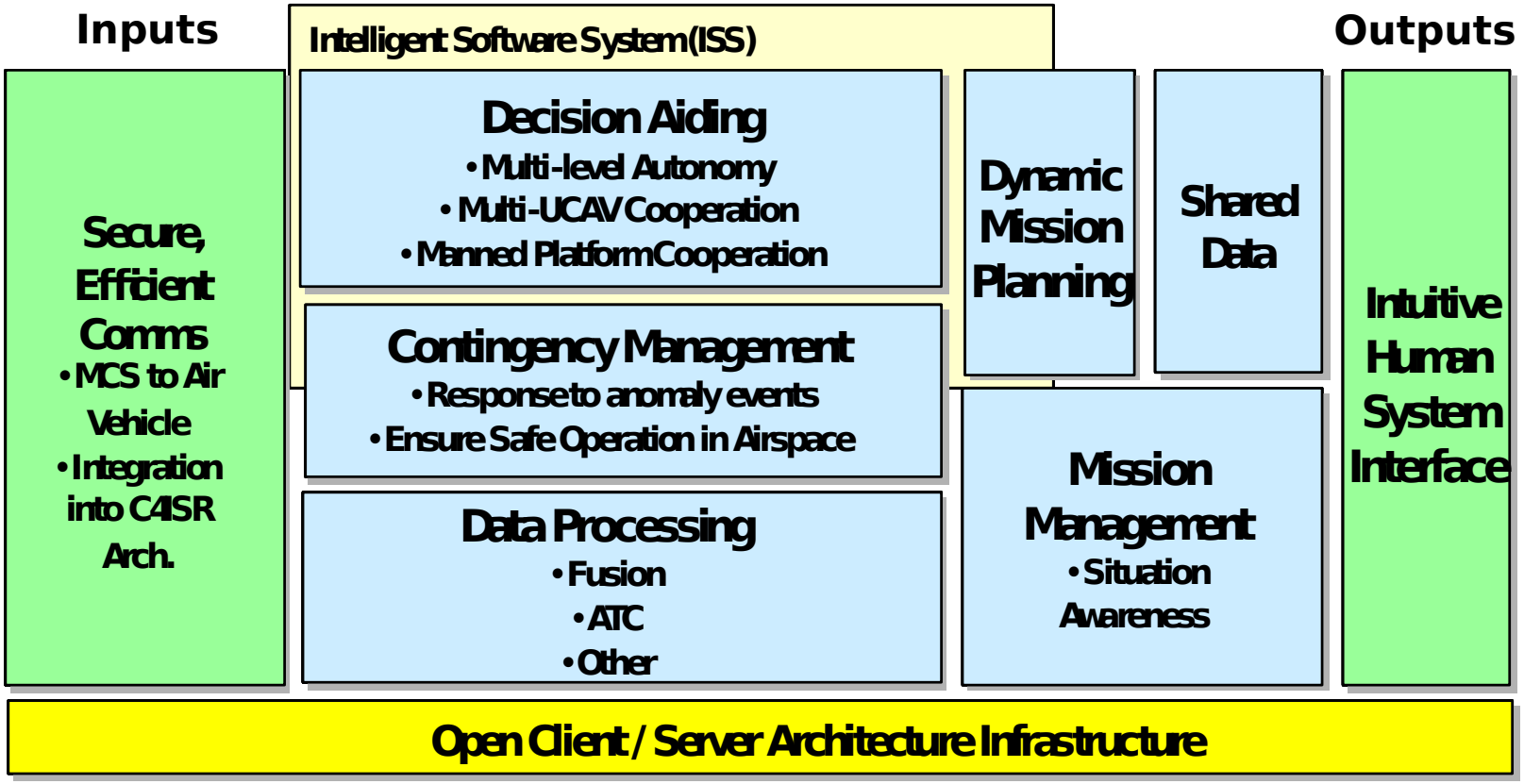
UAVs Must be Fully Integrated Into Network Centric Operations



Key considerations:

- **Level of integrated operations**
  - **Manned / unmanned interoperability**
- **Interoperable / Integrated Operating Environment**
- **UAV Mission Management**

Elements of a Mission Management Architecture



Mission Management Architecture Is Central to Interoperability

Mission Management Elements Reside in Both M...

Decision Aiding (Multi Level Autonomy)

Command Control

Contingency Management

Sensors

Signal / Data Processing (e.g., Sensor Fusion, Automatic Target Cueing

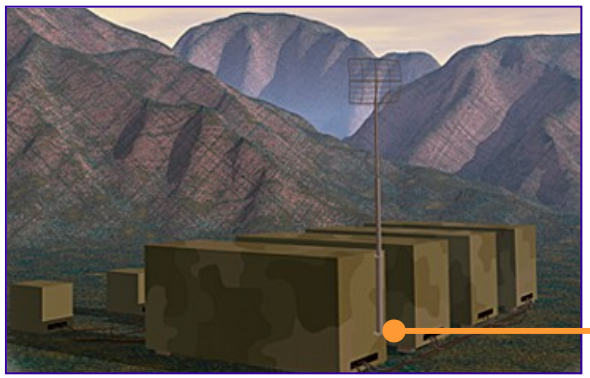
Stores

Bandwidth Efficient Communication

Integrated Vehicle Health Management

Contingency Management

Human System Interface



Bandwidth Efficient Communication

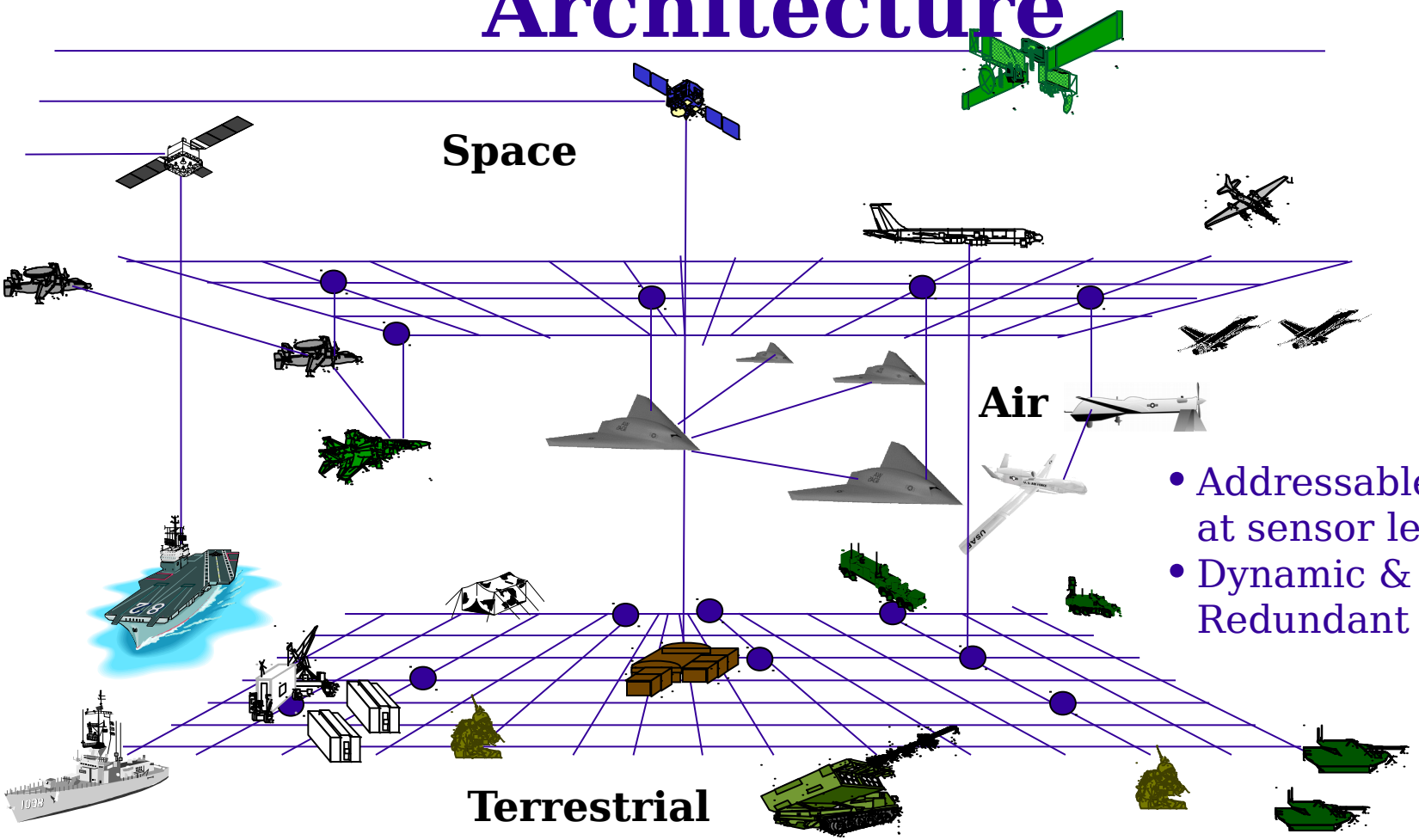
Distributed Data Services

Mission Management

CAOC & External I/F

Decision Aiding (Multi Level Autonomy)

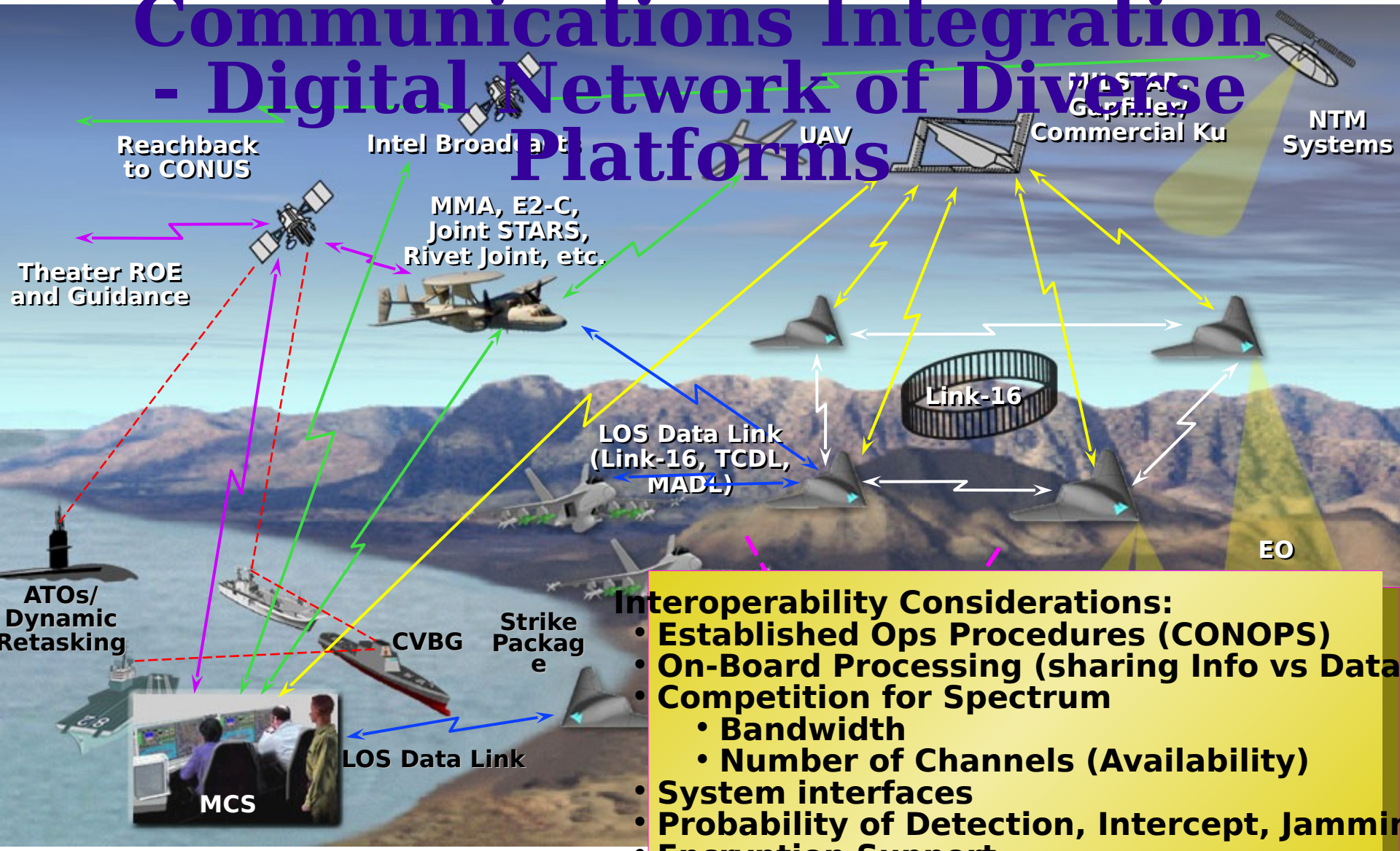
Network Centric Architecture



- Addressable Nodes at sensor level
- Dynamic & Redundant Routing

Information Grid Enables Data Sharing Across a Flexible Robust Network

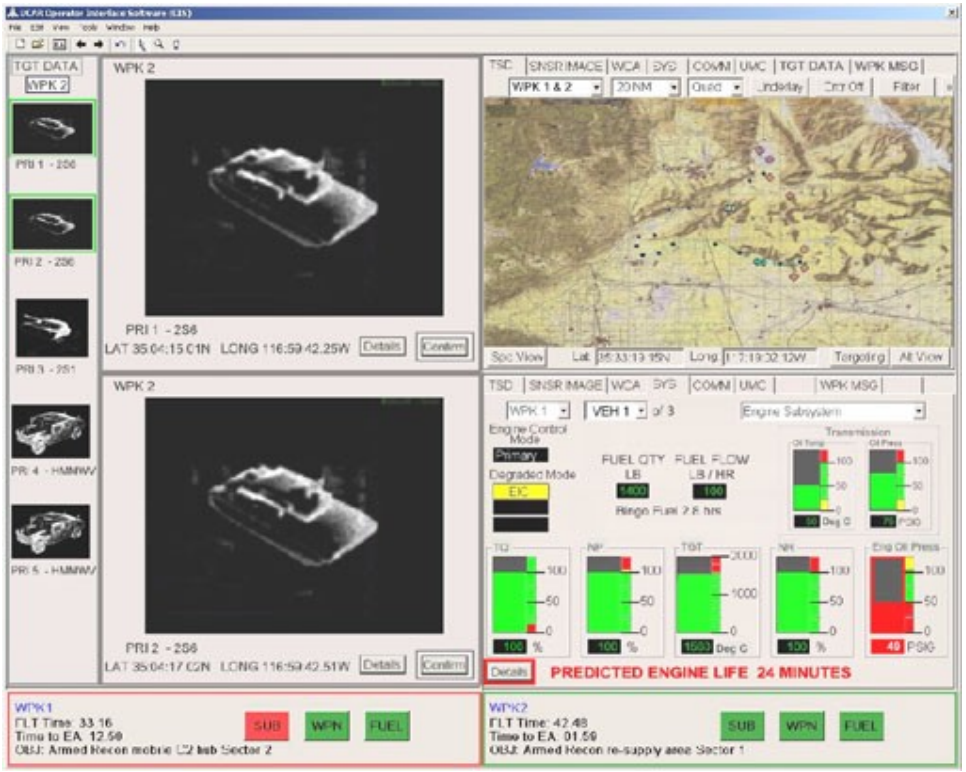
Communications Integration - Digital Network of Diverse Platforms



Interoperability Considerations:

- Established Ops Procedures (CONOPS)
- On-Board Processing (sharing Info vs Data
- Competition for Spectrum
  - Bandwidth
  - Number of Channels (Availability)
- System interfaces
- Probability of Detection, Intercept, Jammin
- Encryption Support

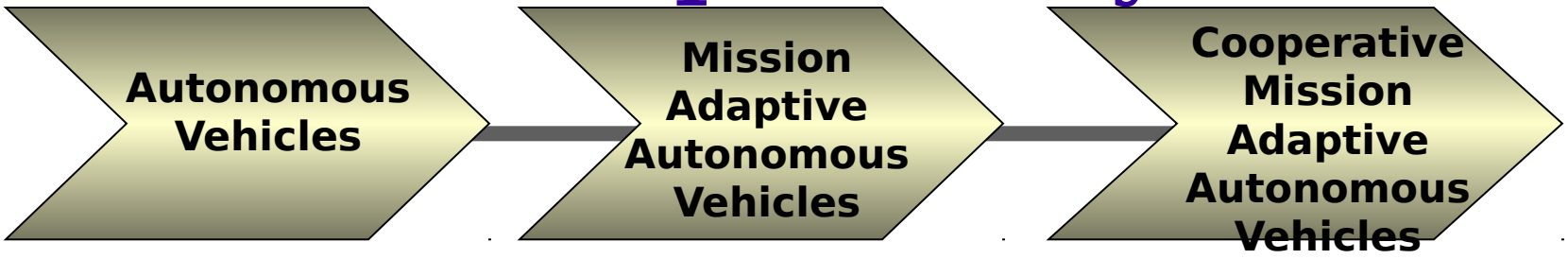
Adaptable Human System Interface



- **Provides Mission Commander the right information to predict and anticipate**
  - **Vehicle situation /location**
  - **Target / threat environment**
  - **Reconfigurable displays for various vehicles and missions**
  - **Multiple vehicle control**

er-Friendly HSI Provides Command & Control for Mixed Operatio

Technologies are Critical for Interoperability



Vehicle Mgmt System

- Vehicle Control
- Trajectory Mgmt
- Flight Control
- Mission Planning

Mission Mgmt System

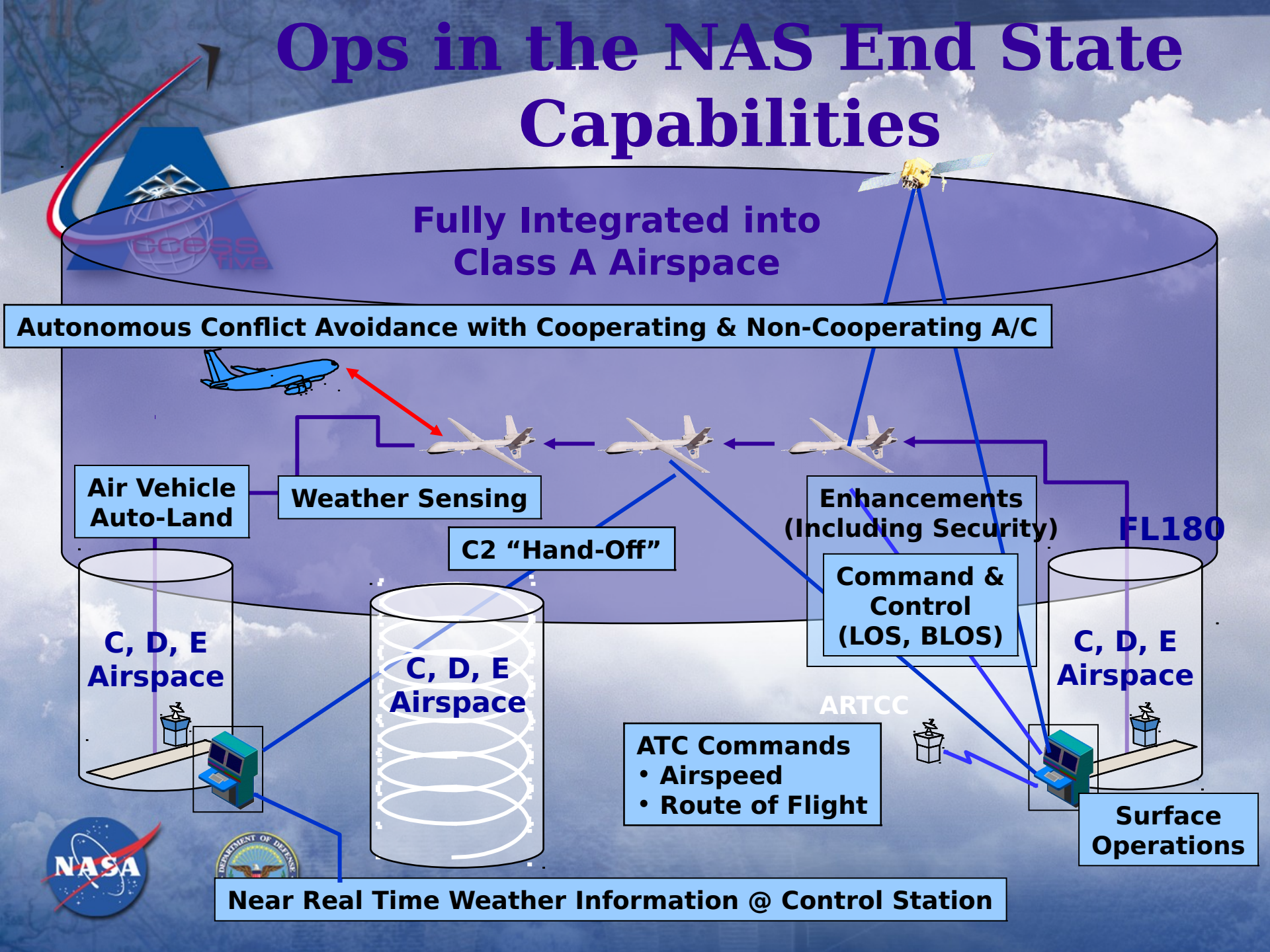
- Mission Monitoring
- Decision Aiding
- Collision Avoidance
- Situational Awareness
- Data Mining/Sensor Mgmt
- Mission Health
- Contingency Mgmt
- Communications with Manned Airspace/Controller

System of Systems

- Integration w/Multiple Mission Control Systems
- Cooperative Autonomous Multi-Platform Mission Control
- Dynamic Re-Planning
- Multi-Vehicle Health
- Formation Flight
- Multi-Agent Collaboration
- Mixed Initiative Behaviors

Cooperative Mission Adaptive Autonomous Systems Enables Higher Level Decision Making & Mission Management

Ops in the NAS End State Capabilities



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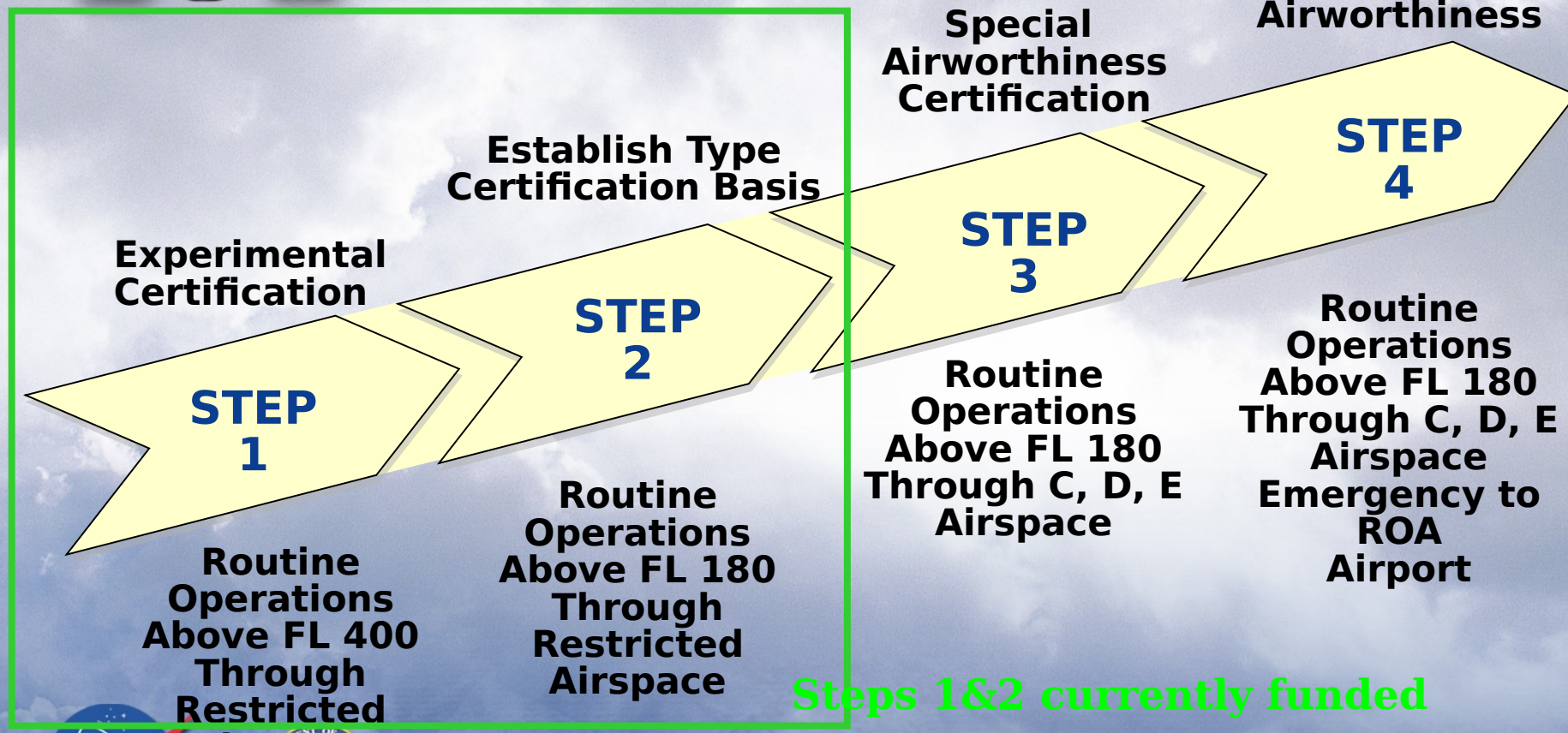
Experimental Certification
STEP 1
Routine Operations Above FL 400 Through Restricted Airspace
Establish Type Certification Basis
STEP 2
Routine Operations Above FL 180 Through Restricted Airspace
Special Airworthiness Certification
STEP 3
Routine Operations Above FL 180 Through C, D, E Airspace
Standard Certificate of Airworthiness
STEP 4
Routine Operations Above FL 180 Through C, D, E Airspace Emergency to ROA Airport

Steps 1&2 currently funded

Achieve Routine, Safe and Reliable Access in the NAS for HA

Summary

- Interoperability of diverse systems is critical to UAV future
  - Expanding roles for military applications
  - Civil and commercial applications
  - Mixed operations with manned aircraft
- Technologies required for interoperability
  - Robust and secure communications via multiple links
  - Key Network Centric System Interface Standards
  - Adaptable cooperative autonomy for command & control of vehicle and sensors
  - Adaptable User-friendly Human Systems Interface
- Regulatory and policy issues must be addressed to enable UAV's to operate in the NAS